NATIONAL BUREAU OF STANDARDS REPORT

10 632

IDENTIFICATION OF POTENTIAL BUILDING MATERIAL SOURCES OF LEAD POISONING

U.S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

NATIONAL BUREAU OF STANDARDS

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IDENTIFICATION OF POTENTIAL BUILDING MATERIAL SOURCES OF LEAD POISONING

Milestone Report (2)

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ABSTRACT

Lead poisoning is a disease of epidemic proportions currently afflicting several hundred thousand children in the United States. Since more than 90% of the known cases of plumbism were caused by ingestion of paint and little information is available about the extent of usage of such paints in housing, a methodology was developed to estimate the extent of leaded paint usage over a period of years.

By analyzing paint pigment production data, and paint production figures, when they were available, the surface coverages of leaded paints produced in several years were estimated. This information was combined with an estimate of the surface area of a dwelling unit to obtain an approximation of the number of residences painted with leaded paint in a particular year.

Common household items that could be sources of lead are also listed.

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IDENTIFICATION OF POTENTIAL BUILDING MATERIAL SOURCES OF LEAD POISONING

1. INTRODUCTION

Lead poisoning in children is an alarming disease of epidemic proportions. Although the exact number of cases is not known, "We know that almost 200 children die from lead poisoning every year, and 12,000 to 16,000 are actually treated and survive. Tragically half of these affected children are left mentally retarded, and only one case in 25 is actually treated. What this means is that almost 400,000 children may be poisoned...".[1/] As many as half of the children afflicted with this malady will develop permanent handicaps such as kidney damage, blindness, impaired learning, and mental retardation. Therefore, it is of great importance to identify the sources of lead poisoning so that they can be eliminated from the environments of children.

In general, cases of lead poisoning are found in old dilapidated housing. According to the 1960 Housing Census, 30.6 million of the 53.0 million occupied housing units were built prior to 1940, and of these units, 7.4 million were classified as deteriorating or dilapidated.[2/] Approximately 1.3 million apartments presently standing in New York City were built before the second World War. Each one is a potential poisoner of children.[3/]

More than 90% of childhood plumbism has been traced to the ingestion of lead paint.[4/] Since paint is the primary source of lead poisoning, an attempt has been made to determine the history of lead paint production and the extent of its usage and distribution in housing.

Since numerous other building materials and components, as well as common household items, are being manufactured with lead today, or have been in the past, a list of those items has been compiled for this report.

2. ANALYSIS OF THE EXTENT OF THE LEAD POISONING HAZARD

2.1. General Comments

White lead is the oldest pigment known to man and has been used since the time of the Egyptians. Until the 1930's it was the major white pigment used in paints. Gradually zinc oxide, lithopone, and titanium dioxide were introduced and began to capture part of the pigment market. Each brought unique properties of its own so that when they were combined with each other, or with lead, a cheaper paint could be made without sacrificing quality. Even after the introduction of other white pigments, many painters still considered white lead paints to be the best paints available and would use only pure white lead paints when they wanted to do quality work.

Lead compounds were used in paints primarily as a pigment, although leaded materials were also added as a coloring agent or as a drier. When used as a pigment, lead compounds contributed more valuable properties to paint than any other single ingredient.[5/] Leaded pigments have a chemical affinity for oil paint vehicles. They stabilize the paint by retarding decomposition and plasticize it by increasing its flexibility. Thus, the lead pigment "becomes an integral part of the paint film and actually reinforces the paint, resulting in a tough, flexible film, unusually resistant to embrittlement." [6/] Since no other pigment had such hiding power and color retention in addition to the other desirable properties, it is easy to see why lead pigments remained popular over a long period of time although they were fairly expensive.

It is commonly believed that leaded paints for interior surface finishes of homes were not used after about 1940, because of the increased usage of other pigments (especially titanium dioxide), the high cost of leaded pigments, and the recognition of the toxicity of lead paint. However, no law was passed at that time banning their sale or use and it was not until 1955 that the American Standards Association proposed a voluntary standard [7/] limiting the lead content in paint for interior uses to no more than one percent lead

by weight of the non volatile solids.

Although there has been much discussion and disagreement about when lead paints ceased to represent a substantial percentage of the total paint production, no statistics exists on the volume of lead bearing paints marketed as a percentage of the total paint production over time. In order to determine the distribution of housing containing lead paint it became necessary to estimate paint production during years for which actual figures were not available.

2.2. Paint and Pigment Production

The only consistent historical source of data concerning the sales or production of paint is the Census of Manufactures (1899-1967). Data relating to the production of pigments is available in the Minerals Yearbook and Minerals Resources, publications of the Bureau of Mines.

2.2.1. Total Paint Production

Since total paint production was not available prior to 1954, it was necessary to combine data for ready mixed paint volumes with gallons of paint calculated from paste pigment weights. Data for dry pigments was not included since those pigments were consumed in making the paste and ready mixed paints.

Production of leaded paints was estimated by summing the volumes derived from data for dry pigment production and lead paste production because of the unavailability of data for ready-mixed lead paint.

Total paint volume production was determined by using the "Paint and Varnish" chapter of the Census of Manufactures as a basis. Until 1937 paint was reported in two categories: ready mixed gallons and pounds of paste. To estimate the total paint production, the reported pounds of paste were converted to gallons, using the factors calculated from typical paint formulations. (See Appendix A) These figures were than added to the data for ready mixed gallons, giving the total paint production for any given

year. This data is reported in Table I, Total Paint Production 1899-1937 (Estimated).

The more detailed data available for the years 1939 and 1947 shows a breakdown of the intended use of the ready mixed gallons. Since our goal was to determine the paint used for housing, it was possible to eliminate those categories that were obviously not applicable to residential use. This data, combined with gallons of paste paint, is reported in Table II, Total House Paint Production 1939-1947 (Estimated). However this total does not mean that all of this paint was used in residences, since a certain portion was most likely applied to commercial establishments. We have no way of knowing how much was used for applications other than housing. Thus Table II represents the total amount which may have been used for housing.

Starting with the 1954 Census of Manufactures, all paint production was reported in gallons with complete classification as to the intended use of those paints listed. Again only those categories with possible application to housing are included in Table III, Total House Paint Production 1954-1967. In order to determine the total paint production for all purposes from 1939-67 the sum of all categories of paints listed was taken, excluding varnish and lacquer products. This is reported as the total paint production in Table IV, Summary of Census Data 1939-1967, which also includes paint data from Tables II and III.

2.2.2. Lead Paint Production

An estimate of the leaded paint production was made by converting the tons of white lead, leaded zinc oxide pigments, and white lead paste to gallons of paint on the basis of common formulations. Other lead pigments were not considered when calculating the volume of lead paint produced because they were not commonly used in residential or house paints.

Pounds of dry white lead pigment were converted to gallons of paint, by assuming that they were used in mixed pigment formulations, using a factor of 3.5 lb./gal. This factor was calcu-

Table I

TOTAL PAINT PRODUCTION 1899-1937 (ESTIMATED)*

	Million Gallons								
	1899	1904	1909	1914	1919	1925	1929	1935	1937
White Lead[1]	7.9	15.2	16.3	18.6	15.7	17.2	15.4	11.2	9.1
Combined Whites[2]	-	-	-	-	-	4.9	6.2	2.6	6.0
ZnO[3]	-	-	-	1.2	1.8	0.9	0.6	0.2	0.6
Red Lead[4]	-	-	-	-	-	0.2	0.3	0.2	0.2
All Other[5]	29.4	20.6	25.4	19.8	22.6	14.0	9.2	5.5	5.7
Water/ Calcimines[6]	1.8	3.6	6.4	8.0	13.8	13.8	19.5	15.6	18.9
Ready Mixed	16.9 / 56.0	22.4 / 61.8	34.3 / 82.4	40.7 / 88.3	59.6 / 113.5	87.7 / 138.8	106.2 / 157.4	90.6 / 125.9	110.3 / 150.8

*Census of Manufactures, 1909-1937

Footnotes 1-6 Pounds of Paste Converted to Gallons of Paint
Factors for Conversion

[1] 15.1 lb./gal.

[2] 10.0 lb./gal.

[3] 8 lb./gal.

[4] 20 lb./gal.

[5] 6.5 lb./gal.

[6] 8 lb./gal.

Table II

TOTAL HOUSE PAINT PRODUCTION* 1939-1947 (ESTIMATED)

	(Millions of Gallons)	
	1939	1947
Paste in Oil		
White Lead[1]	8.6	4.8
Other Pastes Whites	2.6	2.0
Color in Oil	1.9	1.2
Other Oil Paste Paints	1.2	1.3
Oil Paints & Alkyd Vehicle Type, Semipaste		
Interior		2.3
Exterior		4.6
Oil Paints & Alkyd Ready Mixed	69.9	
Interior		39.5
Exterior		64.3
Mill Whites		3.8
Under Coats & Primers	11.8	24.5
Water Paints	4.0 Est	17.1
Enamels	40.3	89.2
	140.3	254.6

[1]Converted from paste using 15.1 lb./gal.

*Census of Manufactures, 1939, 1947.

Table III

TOTAL HOUSE PAINT PRODUCTION* 1954-1967

	Million Gallons			
	1954	1958	1963	1967
Exterior Oil Type				
28511-21 Oil & alkyd vehicle house paints	45.7	50.0	47.3	26.8
28511-22 Sash, trims & trellis enamels	13.9	16.1	18.1	3.8
28511-24 Porch & deck enamels				8.1
28511-25 Undercoaters & primers	10.6	11.6	11.6	7.4
	70.2	77.7	77.0	46.1
Exterior Water Type				
28512-11 All purpose water emulsions	8.9	13.7	19.9	27.1
28512-16 Masonry water emulsion				5.5
28512-19 Other water thinned			6.5	4.1
			26.4	36.7
Interior Oil Type				
28513-52 Flat wall paints	31.8	27.5	22.9	16.9
28513-53 Gloss & quick drying enamels	30.2	29.1	34.5	12.2
28513-54 Semi-gloss				16.1
28513-56 Undercoaters & primers	9.0	6.8	7.7	4.5
28513-59 Other oil paints & enamels/28511-51 mill white	12.0	12.4	6.0	4.9
	83.0	75.8	71.1	54.6
Interior Water Type				
28514-11 Flat				79.2
28514-21 Semi-gloss	32.5	49.7	78.8	4.9
28514-31 All purpose				3.6
28514-98 Other water thinned/28511-00 N.S.K.	26.7	13.6	10.2	6.2
	59.2	63.3	89.0	93.9
Industrial Product Finishes				
28516-44 Sheet, strip, coil coatings including siding				12.0
	221.3	230.5	263.5	243.3

*Census of Manufactures, 1954-1967

Table IV

SUMMARY OF CENSUS DATA*
1939 - 1967

	MILLION GALLONS					
	1939	1947	1954	1958	1963	1967
Total Paint Production	(204)	(324)	342.3	447.7	544.9	545.4
Exterior House	-	-	79.1	91.4	103.4	94.8
Interior House[1]	(88.4)	(160.4)	142.2	139.1	160.1	148.5
Total House Paint	(140.3)	(254.6)	221.3	230.5	263.5	243.3

Figures in parentheses are estimated values.

*Census of Manufactures, 1939-1967. Paint, excluding Varnish and Lacquers.

[1]Estimates for 1939 and 1947 were based on the assumption that 63% of the total house paint was for interior use. (the average value for 1954-67)

lated by averaging common paint formulations. White lead paste was converted with a factor of 15.1 lb./gal. (See Appendix A), by assuming its use in pure lead paint as mixed by the painter. The leaded zinc oxide was converted to gallons by using a factor of 3.0 lb./gal. [8/] The Estimated Lead Paint and Pigment Production (1899-1967), based upon calculations using the above factors, appears in Table V.

Dry pigment data appearing in Bureau of Mines publications was used because similar data in the Census of Manufactures was not catagorized as to intended use by industry. For those years when breakdown of pigment usage was available, average percentages for the usage of each pigment in the paint industry were assumed. The assumption was made that all leaded zinc oxide manufactured prior to 1934 was consumed by the paint industry.

As can be seen in Figure I, Paint Production 1899-1967 and Table VI, Paint and Pigment Production, the total volume of paint produced in recent years has grown rapidly as industrial markets have expanded. Since, as one goes back in time, the paint produced for housing becomes a larger percentage of the total production , it is fair to assume that prior to 1940, much of the paint produced may have been used in housing. Therefore, it appears that in those years when the percentage of lead paint production was high, most of the paint used for housing was leaded.

Paint Pigment Production (1909-1967) is illustrated in Figure II. The use of titanium dioxide as a pigment has increased markedly since its introduction, but it did not replace lead pigments immediately. While the production of lead pigments has declined steadily since the mid 1940's, they have not been completely removed from the market. Considering the lower amounts of lead pigments that are used per gallon of paint today, this lead pigment production may represent a substantial number of gallons of lead paint on the market in recent years.

3. ESTIMATE OF TOTAL INTERIOR SURFACE AREA OF A DWELLING UNIT

By multiplying the gallons of leaded paint produced in a given year by a factor of 450 square feet (sq. ft.) of coverage per gallon,

Table V

ESTIMATED LEAD PIGMENT & PAINT PRODUCTION

Year	PIGMENT (million pounds)			PAINT 1899-1967 (million gallons)			
	White Lead		Leaded Zinc Oxide Dry	White Lead		Leaded Zinc Oxide Dry[3]	Total Leaded Paint
	Paste	Dry		Paste[1]	Dry[2]		
1899	119.0	123.1	-	7.9	35.2	-	43.1
1904	229.6	62.5	-	15.2	17.9	-	33.1
1909	246.6	85.3	13.6[4]	16.3	24.4	4.5	45.2
1914	281.4	71.6	22.6	18.6	20.5	7.5	46.6
1919	237.4	80.5	55.2	15.7	23.0	18.4	57.1
1925	260.2	142.9	63.4	17.2	40.9	21.1	79.2
1929	232.9	150.4	54.2	15.4	43.0	19.1	76.5
1935	169.6	117.6	59.2	11.2	33.6	19.7	64.5
1939	129.4	119.6	83.0	8.6	34.1	27.7	70.4
1947	71.9	102.9	156.0	4.7	29.4	52.0	86.1
1954	18.8	34.8	67.4	1.2	10.0	22.5	33.7
1958	12.1	25.6	46.0	0.8	7.6	15.3	23.7
1963	8.4	20.5	29.8	0.6	5.9	10.0	16.5
1967	3.1	14.6	17.2	0.2	4.2	5.7	10.1

Pigment data form Bureau of Mines, Minerals Yearbook and Minerals Resources, except white lead prior to 1954 is from Census of Manufactures.

Footnotes 1-3 Pounds of Pigment Converted to Gallons of Paint
Factors for Conversion
[1] 15.1 lb./gal.
[2] 3.5 lb./gal.
[3] 3.0 lb./gal.

[4] 1910

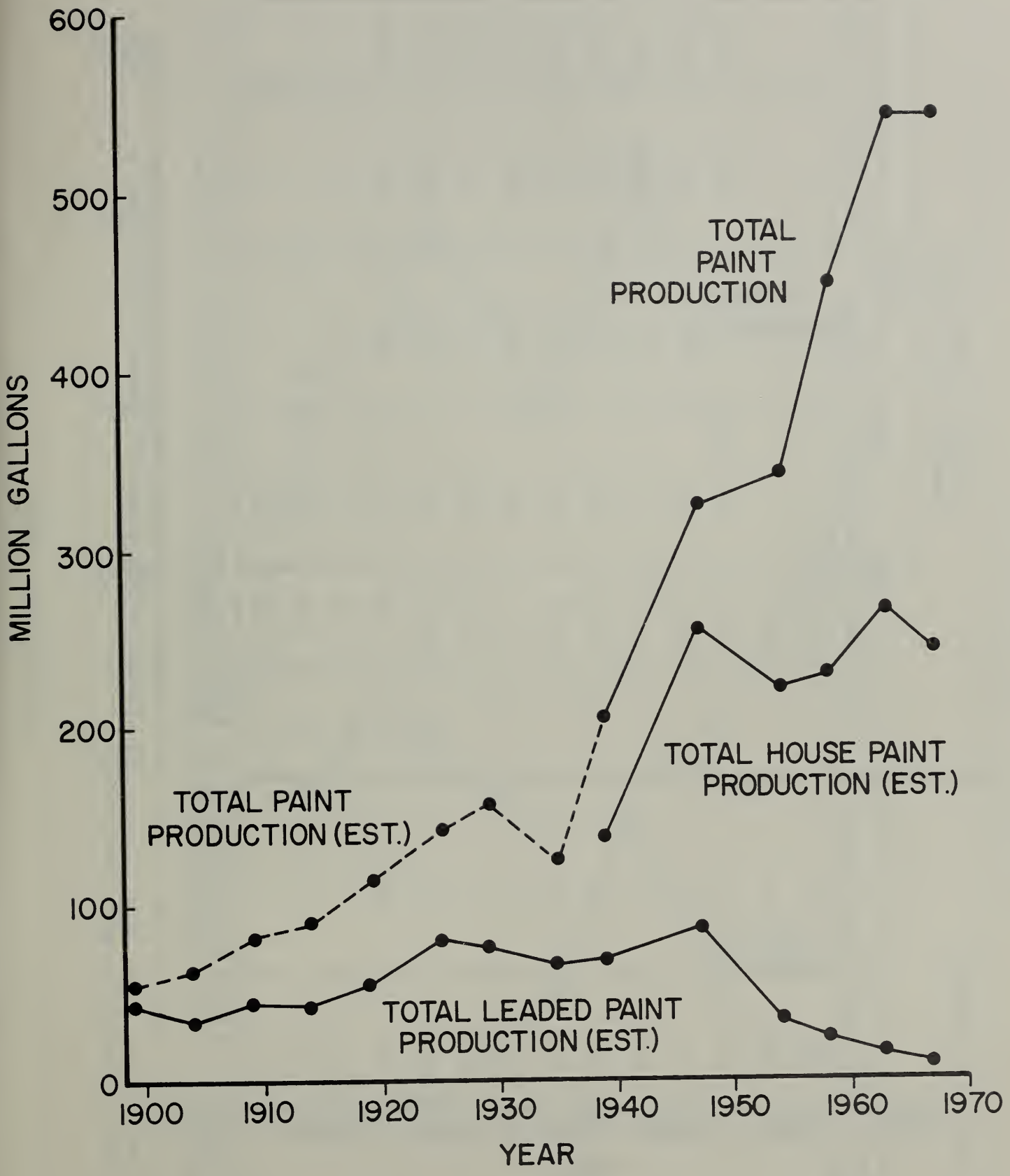

Figure 1. PAINT PRODUCTION (1899-1967)

Table VI

ESTIMATED PAINT AND PIGMENT PRODUCTION

PAINT (Million Gallons)				PIGMENTS (Thousand Tons) Consumed by Paint Industry					
						Other			
Years	Total Paint Production[1]	Leaded Paint[2]	% Leaded Paint	TiO_2	Leaded[3]	Zinc Oxide[4]	Lithopone[5]	Iron Oxides	Misc.
1899	56	43.6	78	-	126.1	-	-	-	-
1904	62	34.1	56	-	146.1	-	-	-	-
1909	82	46.3	56	-	172.8	14.2[6]	9.5[6]	55.8	147.2
1914	88	47.8	54	-	187.8	21.5	24.7	46.5	149.5
1919	114	58.1	51	-	186.6	30.6	58.8	101.1	222
1925	144	80.3	56	2.8	233.3	39.3	108.7	44.4	241.8
1929	157	77.5	48	7.7[7]	218.8	41.8	150.8	57.8	248.1
1935	126	65.2	52	41.2	173.2	25.3	124.6	56.2	237.1
1939	204	70.9	35	70[8]	166.0	25.3	114.0	51.0	295.8
1947	324	86.5	27	184	165.4	32.9	134.8	92.0	288.1
1954	342	33.8	9.9	233	60.5	31.2	32.2	89.5	219.1
1958	448	22.8	5.2	271	41.9	33.3	-	-	-
1963	545	16.5	3.0	323	29.4	34.4	-	-	-
1967	545	10.1	1.9	387	17.5	24.5	-	-	-

Pigment data is from Bureau of Mines Minerals Yearbook and Minerals Resources except iron oxide and miscellaneous are from the Census of Manufactures. TiO_2 from Titanium [3], Table 24-4 using 70% of total pigment production prior to 1947.

1 From Tables I and IV.
2 Interior and exterior paint.
3 Includes white lead and leaded zinc oxide from Table V.
4 Prior to 1929 assume 26% consumed by Paint Industry.
5 Prior to 1927 assume 75% consumed by Paint Industry.
6 1910.
7 1930.
8 1940.

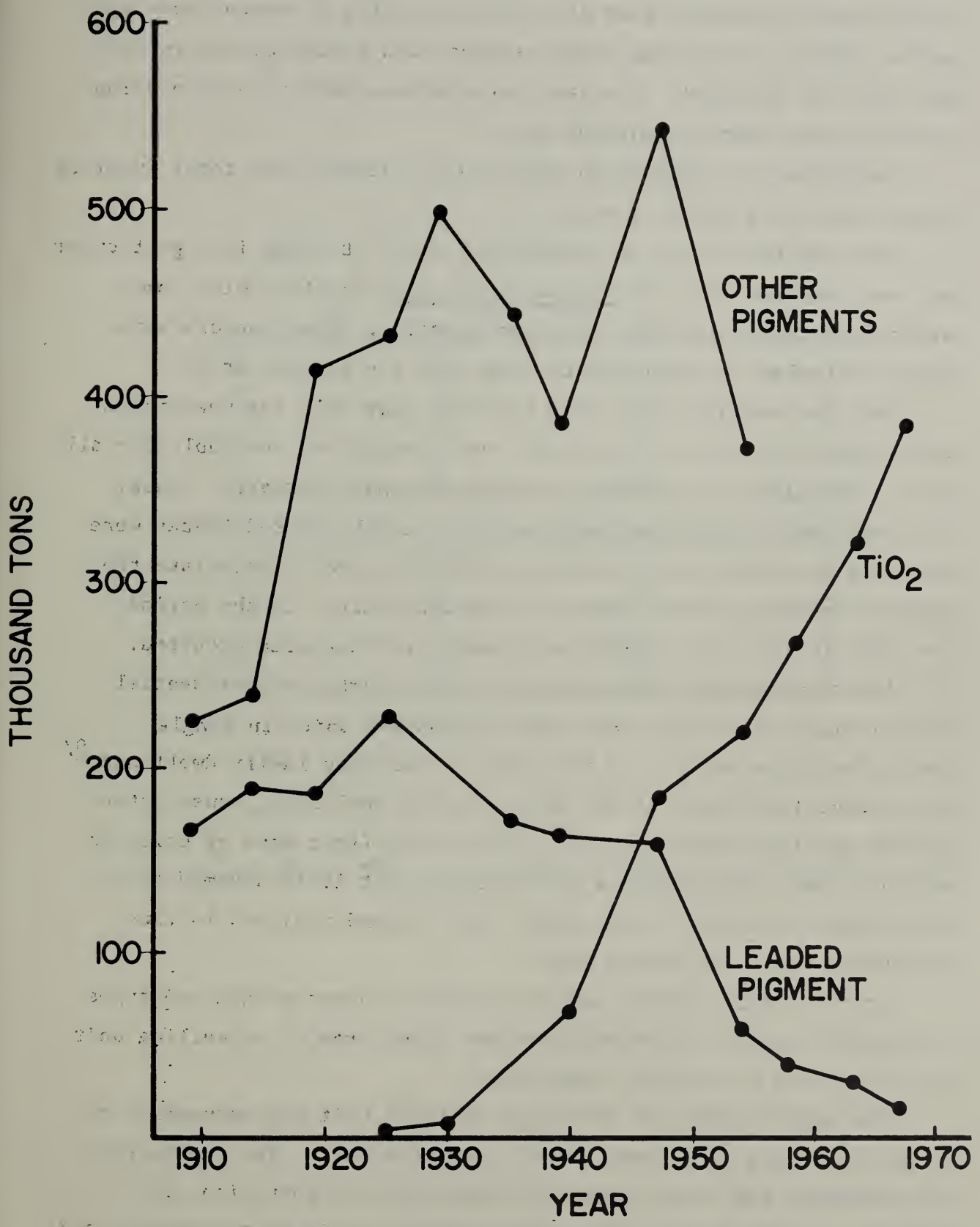

Figure II. PAINT PIGMENT PRODUCTION (1909-1967)

the average spreading rate for an interior paint, the total surface area covered by leaded paints has been calculated. Using an estimation of the interior surface area of a dwelling unit, an approximate value for the number of dwelling units painted with leaded paints in that year has been obtained. The same calculations were also made using total interior paint production data.

The following methodology was used to estimate the total interior surface area of a dwelling unit.

Data for the number of residential units standing in a particular year was obtained from the Census of Housing. Together with some assumptions concerning data and room geometry, these factors were used to calculate an approximate value for the surface area.

Data for average floor area has been kept only for new single family homes constructed in a given year and is not available for all years. From 1940 to 1970 this average area has increased. Thus, since most of the existing dwelling units in the United States were not built in recent years, data for 1940 was used to calculate the average interior surface area of a dwelling unit. In the period from 1940 to 1955, no significant change in floor area occurred.

According to the 1940 census the total number of residential units occupied was 37,325,470, with 24,908,955 units in single family dwellings and 12,416,515 units in multiple family dwellings.[9] The average floor area of new single family dwellings, constructed in 1940 was 1177 square feet.[10] The average floor area of units in multiple family dwellings is not available but it is assumed to be 60% of that in single family units (See Appendix B), and is thus calculated to be 706 square feet.

From the total number and average floor areas of the two types of dwelling units, the overall average floor area of a dwelling unit was calculated to be 1021 square feet.

The median number of rooms per dwelling unit was assumed to be 5, not including bathrooms, foyers, and corridors. For the purpose of estimating the total number of linear feet of partition, the assumption was made that the average dwelling unit is rectangular and

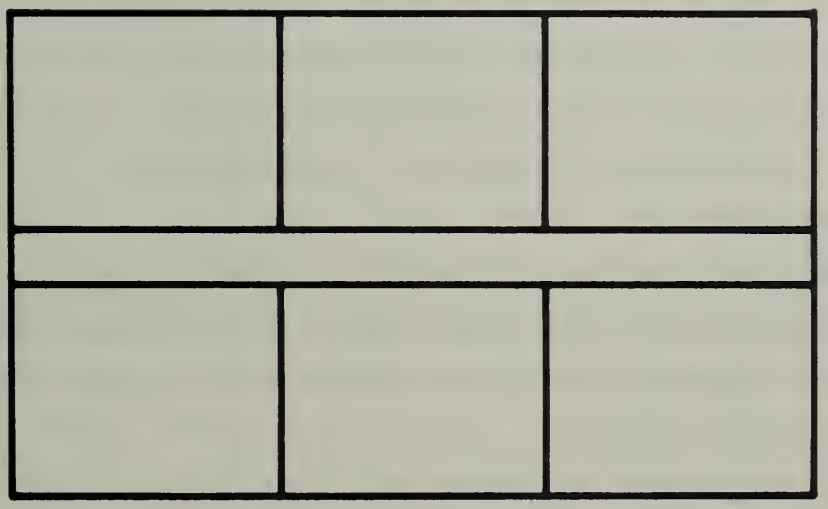

Figure III. MODEL FOR CALCULATION OF DWELLING UNIT SURFACE AREA

composed of 6 compartments arranged on both sides of a corridor. (See Figure III, Model for Calculation of Dwelling Unit Surface Area).

Assuming that the extreme limits of the dwelling unit rectangle are the square and double square, the average perimeter of the average rectangular dwelling unit was calculated to be 131.7 feet and the average length in linear feet of interior partition (perimeter walls counted once and the interior partitions counted twice) in an average dwelling unit is equal to three times the perimater or 395.1 feet.

Assuming the average ceiling height to be 8 feet, the total surface area of interior partition of the average dwelling unit equals 3161 square feet. Adding to it the surface area of the ceiling, assumed to be equal to the average floor area, or 1021 square feet, the total average interior surface area is rounded off at 4200 square feet per dwelling unit.

Assuming the entire interior of a home is repainted every three years, or one third of the total area is painted each year, one third of the total painted surface area would yield a value of 1400 square feet painted per year.

4. ESTIMATE OF NUMBER OF DWELLING UNITS PAINTED WITH LEADED PAINT (1939-1967)

Total paint coverage was estimated by multiplying the value for the total gallons of paint by the surface coverage per gallon (450 sq. ft./gal.). The number of dwelling units completely painted per year was obtained by dividing the above value by 4200 sq. ft., the paintable surface area estimated per dwelling unit. The above number of dwelling units is probably underestimated since dwelling units are painted on an average of once every three years. A more realistic figure is obtained by multiplying the above value by a factor of three.

The fraction of lead paint used on interiors out of the total lead paint produced was estimated by assuming that half of the interior paint in 1940 contained lead while only ten percent did in 1970. A linear relationship over the years was assumed for the decline in usage of leaded pigments. The 1970 estimate is based on a New York City paint survey and it is possible that the basis of sampling was

not sufficiently random to completely represent all of the paint sold in that city.[11] That number is being used because of the unavailability of any other data at this time. Table VII summarizes the Estimated Lead Paint Production and Usage in Residential Interiors.

5. OTHER HAZARDOUS MATERIALS

Building materials other than paint and household items contain lead now, or have in the past. Lists of common leaded materials that could be found in housing are given in Table VIII, Common Leaded Household Items and Table IX, Common Leaded Building Materials. Few of these items could be considered as potential sources of lead poisoning today.

Little white lead putty is presently sold, but it has been used in the past. It was applied around windows and, especially in deteriorating housing, can be accessible to children. The compounds being used in some of the present caulks and sealants as activators may be a potential hazard in the future. Lead metal was once popularly used in ornamental building decorations and in windows. Lead pipes have been used in water systems for centuries. Although lead metal is highly insoluble in water, solubility could be affected by acidity. A very real possible source of lead in drinking water are the joint compounds used to seal pipes. If applied incorrectly, particles of leaded material could be carried into water systems. Years ago, white lead in oil or red lead in oil were used as joint compounds. Not all joint compounds contain lead today nor did they in the past.

Collapsible toothpaste tubes have been found to have a very high lead content and lead poisoning cases have been caused by children chewing on them.[12] Lead compounds are also utilized in glazing pottery. If the glaze is improperly fired, the lead is not tied up, and can be leached out. People have been poisoned by continued ingestion of small amounts of lead from improperly glazed pottery.[13] Other lead bearing items which children may chew or ingest include paint on pencils,[14] pieces of linoleum, cast toys, and plastics

Table VII

ESTIMATED LEAD PAINT PRODUCTION AND USAGE IN RESIDENTIAL INTERIORS

		1939	1947	1954	1958	1963	1967
Total Paint Production	MG	(204)	(324)	342	448	545	545
All Interior House Paints	MG	(88)	(160)	142	139	160	149
All Lead Paints	MG	(70)	(86)	(34)	(24)	(17)	10
Interior Lead Paints [1]	MG	(35)	(34)	(11)	(6)	(3)	(1)
Coverage, All Interior House Paints [2]	BSF	(40)	(72)	64	63	72	67
Coverage, Interior Lead Paints [2]	BSF	(16)	(15)	(5.0)	(2.7)	(1.4)	(0.5)
Total Housing Stock (Occupied) [3]	MDU	(34.5)	(40.5)	(47.0)	(51.0)	(56.0)	(59.5)
Est. No. D.U. Interiors Painted	MDU						
All Interior Paints [4] (4200 SF/DU)		(9.5)	(17.1)	15.2	15.0	17.1	16.0
All Interior Paints [5] (1400 SF/DU)		(28.6)	(51.4)	45.7	45.0	51.4	47.9
Interior Lead Paints [4] (4200 SF/DU)		(3.8)	(3.6)	(1.2)	(0.6)	(0.3)	(0.1)
Interior Lead Paints [5] (1400 SF/DU)		(11.4)	(10.7)	(3.6)	(1.9)	(1.0)	(0.4)

[1] Based on linear relationship 50%-50% (1940), 10%-90% (1970) interior to exterior lead paint - 1970 estimate based on New York City paint survey. It is possible that the basis of sampling was not random to completely represent all paint sold in New York City.

[2] Based on 450 square feet/gallon coverage

[3] Extrapolated from Bureau of Census Housing Reports

[4] Wall and ceiling surface area for average dwelling unit

[5] One third total paintable surface of dwelling unit

MG stands for million gallons
BSF stands for billion square feet
MDU stands for million dwelling units
Figures in parentheses are estimated values

Table VIII

COMMON LEADED HOUSEHOLD ITEMS

White lead - varnish cement
Litharge - glycerine cement
Varnish
Linoleum
Printing ink
Dyes
Lead backed rugs
Collapsible tubes - tooth paste
Tinsel
Fish sinkers
Pottery - glazing
Enameling ware
Glass
Rubber - (accelerator, toughener)
Matches
Ceramic frits
Dress weights
Cast toys - soldiers
Solder
Plastics - stabilizer

Table IX
COMMON LEADED BUILDING MATERIALS

Paint
- interior
- exterior

Plumbing
- pipes
- solder
- bends
- traps
- ferrules
- caulking lead
- lead wool
- joint compound

Doors and Windows
- cames
- puttyless frames
- expansion joints
- sash weights
- putty
- caulking
- sealants
- glazing bars

Terne Plate
- frames
- doors
- fire-proof construction

Decorations
- finial
- cresting
- spandrels
- cupolas
- spires
- grilles
- hardware

Roofing
- roofing - lead sheet
- flashing
- gutters
- downspouts

Other
- stair treads
- sheet as water proofing (under bathroom tile, shower floors)
- fire sprinklers - low melting alloys

stabilized with lead compounds.

6. CONCLUSIONS

Calculations indicate that the possible number of dwelling units painted with leaded paints may have varied from approximately 11.4 million in 1939 to approximately 400,000 in 1967.

The estimate of the total number of dwelling units painted with lead paint probably may be low for several reasons.

(a) Since white lead paint was regarded as a high quality paint it was used primarily in high quality housing. It is likely that more of the above type of housing is presently standing. This factor means that there exists a higher probability of finding leaded paint in old housing standing today than would be expected from paint production factors.

(b) None of the leaded paint figures include lead tinting pigments such as chrome yellow, chrome green, and chrome orange. Thus the total per cent of leaded paints is actually higher than that calculated in this study. In modern times it is likely that most of the lead in paints actually comes from tinting pigments.

(c) Since red lead paints are used for metal primers, they were not used in calculating the volume of lead paint for residential use. Only white lead and leaded zinc oxide were included in the estimate of the lead paint. Since red lead paint is frequently applied to objects and areas accessible to children, it could easily be a source of lead poisoning. Stair railings, outdoor play equipment such as slides, merry-go-rounds, bars, and sand boxes offer potential sources of red lead paint as a hazard. Small children are apt to chew or suck on any of these items unaware of the danger involved.

(d) Once a can of paint is sold no assurance can be made as to whether the actual application of the material is that for which it was designed. Thus, as frequently happens, exterior paint is sometimes utilized for interior use. Seldom will a homeowner use interior paint outside, however it is easy to rationalize

that if a paint is good enough to withstand the weather and exterior punishment, it is certainly good enough for interior use. Often after painting the exterior, part of a can of paint remains and it is used for brightening up the interior woodwork or windowsills. Or, as one is painting the exterior window area, how easy it is to raise the window and paint the interior sill to be sure both sides are the same color. It is very easy for an exterior paint to find its way into an interior application. Unfortunately few homeowners are aware of the potential poisoning threat and take no precautions. There is no way to estimate the volume of exterior paint applied to interiors, but it is probably fair to say that it is considerable.

The geographic distribution of lead poisoning seems to be concentrated in areas east of the Mississippi River. It was not possible to obtain an explanation for this from lead paint usage figures due to the fact that data for determining the distribution of lead paint sales does not exist. Nevertheless, a generalization can be made. Lead paint has been used primarily for application to wood surfaces. Consequently in an area where masonry or adobe construction was popular, it is quite possible that lead paint was never used extensively and thus the most common source of lead poisoning is not prevalent.

Another factor to consider is that lead paint from exterior applications has also been shown to be a cause of lead poisoning. Porches and other areas with flaking or peeling paint which are accessible to children are a hazard. Pieces of lead paint which have fallen from a building or fence or have been scraped off during repainting and then left at the base of the wall are a potential danger. Children playing in the dirt may ingest the flakes unaware of the hidden source of poisoning.

7. FOOTNOTES

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2. Lin-fu, Jane S., "Childhood Lead Poisoning...An Eradicable Disease", Children, Vol. 17, No. 1, January-February 1970, p. 3.

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APPENDIX A

Calculations of Factors for Converting Pounds of Pigment Paste to Gallons of Paint

Since it was necessary to determine the total paint production over a period of years, a conversion of the paste which was sold by the pound to gallons of paint was required. The composition of these pastes may have changed over the years and each painter diluted or combined the pastes differently for his own purposes. Thus there were no exact conversion factors. Nevertheless, a general conversion factor for each paste was determined, to apply over the time period in consideration.

Knowing the approximate composition of some types of pastes and the nature of the paint in which they would have been used, it was possible to determine the conversion factors for some pastes. Where adequate data did not exist, certain general assumptions were made about paints to determine conversion factors from paste to gallons. A typical non-leaded paint was assumed to contain fifty percent pigment and weigh twelve pounds per gallon unless the pigment composition was known. Paste was estimated to have ninety percent pigment. Thus each gallon contained six pounds of pigment or approximately six and one half pounds of paste. For white lead paste a factor of 15.1 lb./gal. was calculated from typical formulations such as shown in Tables A through E of White Lead --- Its Use in Paint.[1/] Combined whites are known to be heavier than most pigments and thus 10 lb./gal. was used.[2/] For both zinc oxide paste and water paints or calcimines, 8 lb./gal.[3/] was considered to be a reasonable factor. Since red lead is a very heavy pigment, 20 lb./gal.[4/] was used to convert the paste to gallons. For "all other" pastes 6.5 lb./gal. was utilized.

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APPENDIX B

Calculation of the Surface Area of an Average Dwelling Unit

Since a value for the interior painted surface area of an average dwelling unit was necessary to make possible the calculation of the total number of dwelling units painted in a given year, the following approach was used to obtain the above information.

Values for the average square foot area of new single family dwelling units were used as a basis for the estimation of the total painted surface area of an average dwelling unit. This approach was used since no other data was available that could be applied to obtain the above information. Average square foot areas were obtained from New Housing and Its Materials 1940-1956.[1/] Similar information was obtained for the years 1966-1970 from Characteristics of New One-Family Homes: 1970.[2/] The area values for 1940 and 1955 were virtually identical and since square foot values for that time period probably represent median values for housing standing today, they were selected for this determination. The floor area for multiple family dwellings was approximated by assuming it to be 60% of the floor area in a single family residence. The 60% figure was obtained by using data for 1969 and 1970 which was available for both multiple family dwellings [3/] and single family dwellings.[4/] It was assumed that this ratio remained constant over a period of time.

The surface area was calculated as follows:

Let U = Total number of dwelling units in any year,

U_s = Total number of single family dwelling units in any year, and

U_m = Total number of multiple family dwelling units in any year.

Let A_s = Average floor area per single family dwelling unit, and

A_m = Average floor area per multiple family dwelling unit.

By assuming $A_m = \frac{60}{100} A_s$ we can use the formula

(1) $$A = \frac{U_s \times A_s + U_m \times A_m}{U}$$ to find A where

A = average dwelling unit floor area.

Since P_1, the perimeter of a square = $4\sqrt{A}$ and

P_2, the perimeter of a double square = $6\sqrt{\frac{A}{2}}$,

(2) P, the average perimeter = $\frac{P_1 + P_2}{2}$

Let h = ceiling height;

assume h = 8 feet.

S_p, the total interior partition surface area for 6 compartments around a corridor can be calculated by the formula

(3) $$S_p = 3 \times P \times h.$$

S, the total interior surface area per dwelling unit (walls and ceiling) is yeilded by the equation

(4) $$S = S_p + A \text{ where } A = \text{ceiling area.}$$

For 1940 the following results were obtained; where

U = 37.3 million [5/]

U_m = 12.4 million [6/]

U_s = 24.9 million [7/]

A_s = 1177 square feet [8/]

A_m = 706 square feet.

Substituting these values into equation (1), the average dwelling unit floor area was calculated.

$$A = \frac{24.9 \text{ mil.} \times 1177 \text{ sq. ft.} + 12.4 \text{ mil.} \times 706 \text{ sq. ft.}}{37.3 \text{ mil.}}$$

$$= 1021 \text{ sq. ft.}$$

By using equation(2)the average perimeter was found as follows:

$$P = \frac{4\sqrt{1021} \text{ sq. ft.} + 6\sqrt{\frac{1021}{2}} \text{ sq. ft.}}{2} = 131.7 \text{ feet}$$

The total interior wall area, computed by equation (3), yielded

$$S_p = 3 \times 131.7 \text{ feet} \times 8 \text{ feet} = 3161 \text{ sq. ft.}$$

The total interior paintable surface area per dwelling unit, found from equation (4), was

$$S = 3161 \text{ sq. ft.} + 1021 \text{ sq. ft.} = 4182 \text{ sq. ft.}$$

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